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SOIL CONDITIONS AFFECT GROWTH OF HARDWOODS IN SHELTERBELTS[1/]

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ABSTRACT.--Large growth differences were found for hardwoods in shelterbelts on three contrasting soils of western Minnesota. Five years after planting, height growth was outstanding for green ash and Russian olive planted on a moderately fine-textured, somewhat poorly drained soil. Growth was much poorer on coarse-textured or shallow soils. Size of planting stock was not related to growth of trees after planting. OXFORD: 266: 181.32:176.1(776). KEY WORDS: tree growth, stock size.

Shelterbelts are used in the central plains for protecting fields and homesteads (Read 1964, Stoeckeler 1970). But tree growth in shelterbelt areas, as well as in forested regions, differs greatly depending upon the soil and climate where trees are planted. Thus, selecting tree species for shelterbelt plantings requires information about their adaptability to local soil and climatic conditions. Our studies in western Minnesota reveal large differences in growth for trees planted on soils widely different in texture, depth, and internal drainage.

[1/] *A cooperative study with the Minnesota Division of Lands and Forestry. We thank State personnel who provided the seedlings and the planting areas and who assisted with planting, cultivation, and tree measurements.*

THE STUDY AREA

Shelterbelt plantings were made in 1968 on the following three contrasting soils in Swift County, Minnesota:

(1) *Renshaw sandy loam* (Udic Haploboroll, fine-loamy over sandy or sandy-sheletal, mixed). This excessively drained soil has a shallow sandy loam surface soil overlying calcareous outwashed glacial sand and gravel. Topography is level and this soil is considered very droughty.

(2) *Buse loam* (Udorthentic Haploboroll, fine-loamy, mixed). This well drained soil has a very dark-colored loam surface soil overlying calcareous loam and clay loam glacial till. Mottling is evident in the subsoil at about 40 inches indicating moderate permeability. Topography is a knob on a rolling landscape, and surface soils are shallow on the steeper slopes because of past erosion.

(3) *Colvin silty clay loam* (Typic Calciaquoll, fine-silty, frigid). This somewhat poorly drained calcareous soil has developed from glacial lacustrine deposits. Topography is level, internal drainage is slow, and the subsoil is mottled and very calcareous at shallow depths.

Annual rainfall averages about 22 inches per year. The Renshaw area is 15 miles west of the other two areas, and thus may have lower rainfall and greater evapotranspiration.

METHODS

Three species commonly used in shelterbelts were planted in each of the three areas: (1) 3-0 green ash (*Fraxinus pennsylvanica* Marsh); (2) 2-0 Russian olive (*Elaeagnus angustifolia* L.); and (3) 3-0 Siberian peashrub (*Caragana arborescens* Lam.).

Trees were planted 2 feet apart in rows 15 feet apart. On each area, 24 plots were used for each of the three species--a plot was a portion of a row containing 9 to 18 trees. Three stock sizes were used for each species, and each stock size was replicated in eight plots in a completely randomized statistical design (table 1).

Each planting area was plowed and disked in the fall of 1967, and planting was done in May 1968 using a machine planter. All trees were checked to ensure proper planting. Weeds were controlled by cultivation and hand weeding during the first three growing seasons, but only occasional cultivation was done in the fourth and fifth growing seasons.

RESULTS

Survival

Survival of Siberian peashrub and green ash was excellent on all soils regardless of stock size (table 2). Large Russian olive also had excellent survival on all soils, but survival was usually poorer for medium- and small-sized Russian olive. This generally excellent survival probably was due to: (1) favorable weather conditions (cloudy and rainy) during planting; (2) checking to ensure proper planting; and (3) controlling weeds. Most of the mortality resulted from accidental uprooting or burying of the smaller seedlings when they were cultivated during the first and second growing seasons. For Russian olive, uprooting or burying was particularly severe for small- and medium-sized seedlings and, in the Renshaw area, survival of Russian olive also was reduced by flooding in 1969.

Size of Planting Stock

Size of planting stock was significantly related to annual height growth in only a few cases, and few consistent trends were evident. For the three species on each soil area, most large-, medium-, and small-sized seedlings grew similarly in

Table 1.--*Tree species and the size of seedlings planted in each of the three soil areas*
(In inches)

Stock size	Tree species: Siberian peashrub (3-0)		Russian olive (2-0)		Green ash (3-0)	
	Average height	Stem caliper 1/	Average height	Stem caliper 1/	Average height	Stem caliper 1/
Large	15.1	0.29-0.35	23.8	0.35+	24.3	0.35-0.42
Medium	12.4	0.20-0.26	16.8	0.23-0.35	17.1	0.23-0.29
Small	9.5	0.10-0.17	9.8	0.10-0.23	9.5	0.10-0.17

1/ Stem diameter measured 1 inch above the root collar.

Table 2.--*Five-year survival on the three soil areas by tree species and seedling stock size*
(In percent 1/)

Soil series and stock size 2/		Tree species: Siberian peashrub	Russian olive	Green ash
Renshaw	large	88	81	97
	medium	96	3/62	98
	small	93	3/30	94
Buse	large	94	81	88
	medium	94	50	80
	small	72	24	88
Colvin	large	94	96	98
	medium	92	90	98
	small	88	68	92

1/ For each species the survival percents not connected by the same line are significantly different (5-percent level) as determined by the Newman-Keuls (Hartley modification) multiple range test.

2/ See table 1 for stock height and caliper.

3/ Survival of medium- and small-sized seedlings was reduced by flooding in 1969.

height for each of the 5 years following planting; most seedlings that were tall at the time of planting were taller by about the same amount after five growing seasons.

Soil Area

For each of the three species on each soil area, we averaged annual height growth for all 24 plots because few significant growth differences were evident due to seedling stock size. Then we compared both total and annual height growth and found that growth of two species differed greatly on the three soils (fig. 1). Siberian peashrub is a slow-growing shrub, and we found similar growth on the three soils. But growth for both Russian olive and green ash was outstanding on the moderately fine-textured Colvin soil. After 5 years, total height of Russian olive and green ash planted on the Colvin soil averaged 12.3 and 9.6 feet, respectively. In contrast, Russian olive and green ash grew very slowly on the coarse-textured Renshaw soil, and after 5 years total height averaged only 3.3 and 2.7 feet, respectively. Green ash was 22 percent taller on the medium-textured, shallow Buse soil than on the coarse-textured Renshaw soil. Russian olive, however, was only slightly taller on the Buse than on the Renshaw soil after 5 years.

CONCLUSIONS

For the first 5 years after planting, we found similar growth for large-, medium-, and small-sized seedlings. Hence, we conclude that seedling stock size was not closely related to growth of trees planted in our three shelterbelt areas. These results contrast with other studies that show stock size is related to growth of shelterbelt trees (George and Frank 1973). There are two possible reasons for this difference. First, our seedlings were carefully cultivated for the first 3 years after planting, thus early competition from grasses and weeds was controlled. Possibly, stock size would be more closely related to growth and survival where grass and weeds overtop and compete with small-sized seedlings. Second, none of our seedlings had a stem caliper less than 0.10 inch; close to the minimum caliper recommended for hardwoods (Limstrom 1963, Stoeckeler 1937, Stoeckeler and Jones 1957, Williams and Hanks In press). Poorer growth might have been observed if we had also included a very small seedling size class.

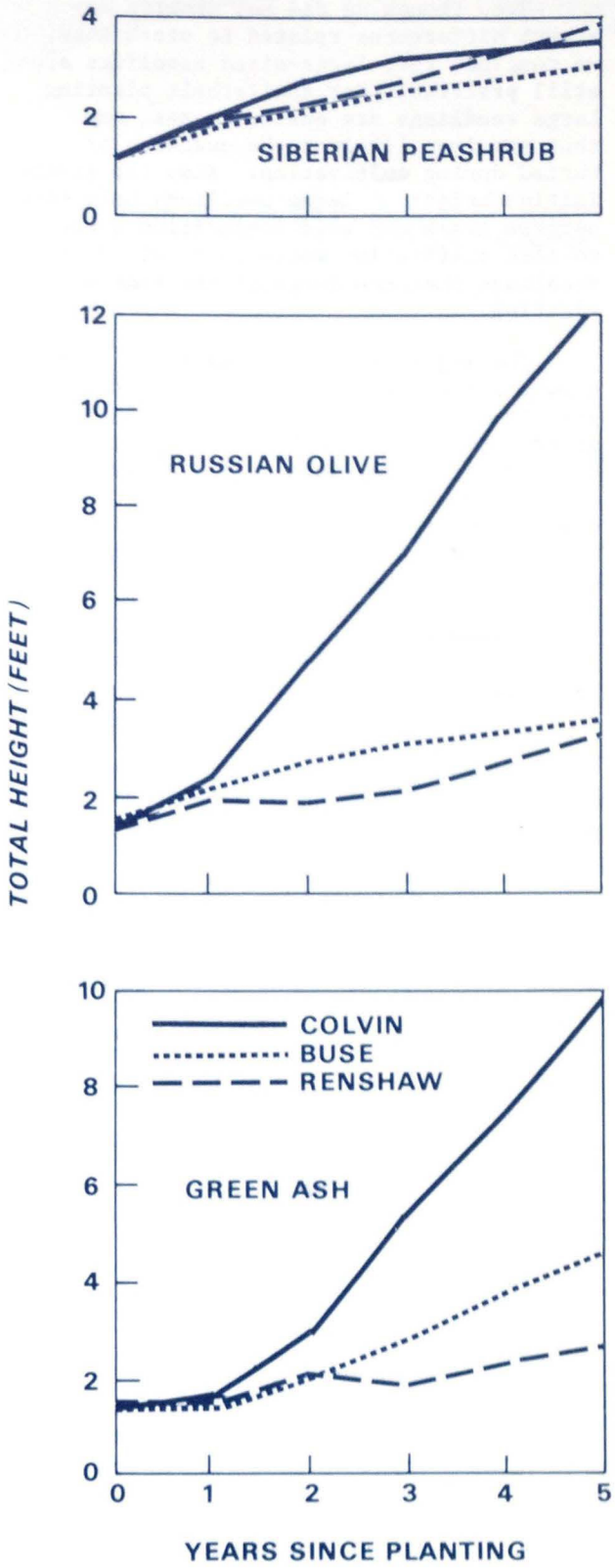

Figure 1.--*Average height growth for Siberian peashrub, Russian olive, and green ash planted on three contrasting soils of western Minnesota.*

Even though we did not observe any growth differences related to stock size, we conclude that large-sized seedlings are still preferable for shelterbelt planting. Large seedlings are easier to see, and thus are less likely to be uprooted or buried during cultivation. Also the greater initial height of large seedlings help them outgrow grass and weed competition sooner so less cultivation would be required for seedlings that are large at the time of planting.

The major finding of our study is that growth differs greatly on soils contrasting greatly in texture and drainage. Outstanding growth occurred on Colvin--an imperfectly drained silty clay loam soil. Poor growth occurred on Renshaw--a droughty, excessively drained sandy loam soil. Tree growth was only a little better on the Buse loam than on the Renshaw sandy loam even though the Buse loam is somewhat finer in texture than the Renshaw soil. However, the Buse soil is located on a fairly steep knob, and soil is shallow because of past erosion.

We can conclude from this study that trees planted in shelterbelts, as well as agricultural crops, have markedly different growth depending upon the kind of soil where they are planted. Hardwoods planted in deep, imperfectly drained, fine-textured soils of western Minnesota, will grow well. Those planted in shallow, coarse-textured soils, however, will grow slowly. Western Minnesota has a great variety of soils in addition to those of this study. Additional site studies are needed so that we can predict how well various shelterbelt tree species will grow when planted on different soils.

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